LCA Methodology

A Framework for Actualising Normalisation Data in LCA: Experiences in the Netherlands

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Abstract

In LCA, normalisation is applied to quantify the relative size of the impact scores. Several sets of normalisation data exist in the Netherlands, which all have a certain degree of unreliability. The purpose of this study is to actualise Dutch normalisation data and to make a framework for deriving these data. In this study normalisation data are calculated for three different levels in order to give the LCA practitioner a more extended basis for preparing the interpretation process. The first level of normalisation contains all impacts relating to activities that take place within the Dutch territory. The second level is based on the Dutch final consumption, which means that import and export are taken into account. The third level is an attempt to estimate impacts in Europe based on European data if possible, and otherwise based on extrapolation from the Dutch situation.

Keywords: Impact assessment; Life Cycle Assessment; Netherlands; normalisation data

1 Introduction

The normalisation step in Life Cycle Assessment (LCA) is regarded as a technique for the initial interpretation of the results of the impact assessment of LCA. The committee draft ISO/CD 14042.33 states the following: 'The aim of the normalisation of impacts is to better understand the relative proportion or magnitude for each impact category of a product system under study' [1]. More specifically, the normalisation step involves dividing the impact scores of a product system by the overall magnitude of the impact categories for a certain area and a certain period of time (see formula). In doing so, all impact scores are expressed in the same dimension of time and space. This increases the comparability of the results of the different impact categories [2]. In this way, insight is gained into the significance of the impact scores of a product system.

In formula [3]:	$\forall j$	:	$N_j = S_j/A_j$
	j	:	impact category
	N	:	normalised impact score
	S	:	calculated impact score
	A	:	normalisation value

The execution of the normalisation step requires reliable and up to date normalisation data, which is lacking at the moment. Several sets of normalisation data are currently being used in the Netherlands [4 - 7]. The differences between normalisation data easily vary up to a factor of ten (→ *Fig. 1*), while it is not often clear why these differences exist. This hampers the interpretation of LCA results.

Therefore, the Institute for Inland Water Management and Waste Water Treatment (RIZA) and the Ministry of Housing, Spatial Planning and the Environment (VROM) initiated a normalisation study, to be executed by IVAM Environmental Research, Utrecht University, and PRé Consultants [8]. The purpose of this study is to actualise Dutch normalisation data following a transparent procedure with regard to data selection and data conversion. The procedure is meant to be a framework for actualising normalisation data in the future.

2 Choice of Normalisation Levels

The normalisation step in LCA is a technique for the initial interpretation of LCA results, which can be followed by a weighting step (e.g. panel weighting, DtT weighting, monetary weighting). The scale of a normalisation level should match with the scale of an eventually following weighting step. After all, LCA results are ultimately meant to contribute to a decision-making process, mostly concerning products, but sometimes also concerning other systems.

In this study, it is presumed that the location and geographical extension of the life cycle of a product system is relevant to the scale or type of normalisation data to be applied. In practice, this means that normalisation data can be demarcated on the basis of geographical grounds matching the decision-making process.

Another criteria for choosing or defining a normalisation level is coherence between system boundaries of the life cycle under study and normalisation data. Geographical demarcated normalisation levels can have some serious drawbacks in the scope of a decision making process. This is especially the case in a relatively small and economically open country such as

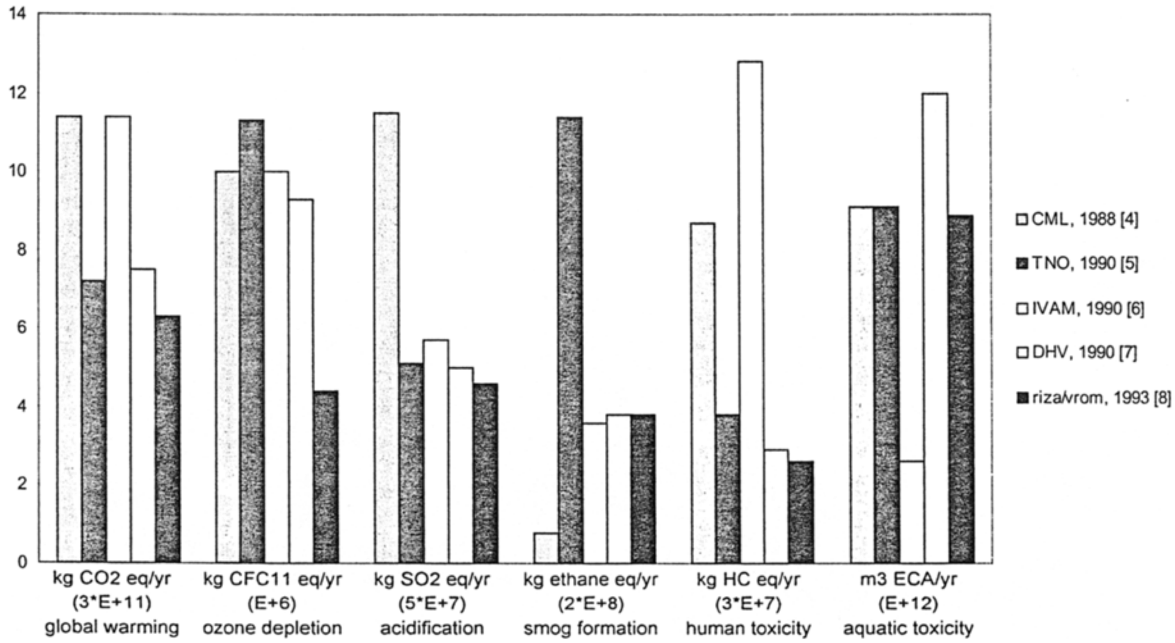

Fig. 1: Comparison of several existing normalisation sets in the Netherlands for six impact categories [4 - 7]. The new set from the background document of this study is also included [8]. The years mentioned in the legend refer to the applied basic year of the registered emission data

the Netherlands. The Dutch economy is characterised by a relatively large production of industrial commodities for the final consumption. On the other hand, some important raw material extraction processes with a high environmental impact are lacking, such as the mining of abiotic resources and wood production. To overcome this drawback, a normalisation level could be demarcated in relation to the final consumption in the Netherlands.

A final criteria is the availability of normalisation data. The availability of normalisation data (what is monitored?) is closely related to decision making and the definition of environmental themes (what are important issues?). In **Table 1**, a preliminary framework is given of four scales or levels of normalisation and the three mentioned criteria with regard to their suitability for LCAs. It can be considered as a conceptual framework in which the study has been performed. It can also be used as a starting point for the LCA practitioner in selecting and defining normalisation levels.

Among LCA practitioners, different opinions prevail on how normalisation data should be defined. An important issue is whether or not it is preferable to define normalisation levels on a world scale. A theoretical advantage of a normalisation level on a world scale is the coherence with system boundaries and allocation in product LCAs. In practice, however, there is a substantial lack of reliable world data for many environmental themes, which makes it impossible to achieve this level at the moment. Furthermore, decision making concerning the applied environmental themes in the Dutch LCA methodology is often related to national issues (e.g. nutrification, acidification). Worldwide themes like global warming and ozone layer depletion can easily be confronted with national reduction targets, a system by which annual progress

Table 1: Criteria for the selection and definition of different normalisation levels

Criteria	National (Dutch) territory	West European territory	National (Dutch) final consumption	World
Connection to decision making	Suitable for many LCAs with regard to Dutch production systems due to the link with national policy targets.	Suitable for LCAs with regard to product systems of which EC policy is applicable or for companies operating on EC level.	Theoretically the best type of normalisation for priority setting in the scope of consumption related product policy.	Suitable for companies acting on world level for some world scale environmental themes or indicators (global warming, ozone depletion, energy use).
Availability of normalisation data	High due to coherence between definition of Dutch environmental issues, target setting policy and definition of environmental themes in the Dutch LCA guide.	High for some environmental themes, very low for some others. Identification and collection of data differ much per country depending on actual issues and policy making.	Partly high, partly lacking. Part of data can be calculated on basis of data of Dutch territory.	Sufficient for the world wide themes: global warming, ozone depletion, depletion of abiotic resources, energy use. Not sufficient data available for other themes.
Consistency with system boundaries	Depends on life cycle under research and decision making questions. Can be problematic for national product policy.	Depends on life cycle under research. Can be problematic due to low representation of e.g. raw materials production.	Theoretically consistent.	Theoretically consistent.

is monitored. The following three normalisation levels have been chosen[1]:

- Dutch territory, concerning all environmental interventions in one year (1993/1994) related to human activities within the Dutch territory (allocation problems arise due to import and export, but are not accounted for). This level has often been used in former studies [4 - 7], and was mainly chosen due to the availability of data in the Netherlands. Generally speaking, this level could be applied in LCA studies that have a national space dimension, like the choice of cleaning technologies for contaminated sediment in the Netherlands.
- Dutch consumption, concerning all environmental interventions in one year (1993/1994) related to the consumption of Dutch end consumers, including the total chains of production and waste processing that result from this consumption (allocation problems arise and are 'solved' using Input-Output analysis). This level is generally chosen because of the perfect match with the product system boundaries of the Dutch final consumption, which means that import and export are taken into account. This level could be applied to Dutch consumer goods, for example for the LCA-studies performed for the Dutch eco-labelling system.
- West European territory, concerning all environmental interventions in one year (1990/1994) related to human activities in the West European territory (allocation problems arise, but are not accounted for). This level fits LCAs with a West European space dimension. It could be applied to products that have a European market. It could also be useful to companies operating on an international level, like multinationals which are practically all active in the field of LCA.

3 Methods

The computation of normalisation data for LCA involves a search for appropriate data sources and data conversion techniques starting from the requirements set by the LCA methodology itself and LCA practice. Part of this study involved a framework for the determination of normalisation data (→ *Fig. 2*).

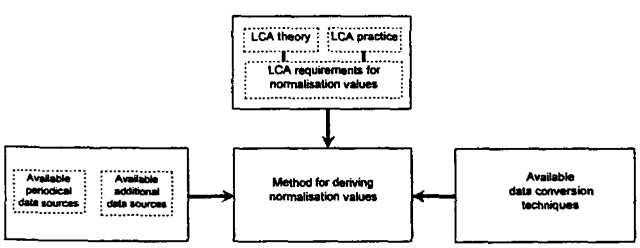

Fig. 2: A framework for the determination of normalisation data

In theory, normalisation data should be determined as prescribed in the LCA method applied most frequently. As far as the Dutch LCA practice is concerned, this would still be the LCA guide of CML [9]. However, the user is allowed to make several methodological choices in this guide. This is especially relevant in the case of allocation and system boundaries, but also where it concerns a definition of the parameters energy and solid waste. The following general methodological choices have been made with regard to the determination of normalisation data:

- Pesticide emissions are calculated on the basis of two types of demarcation of the economic and the environmental system, resulting in two normalisation values for terrestrial ecotoxicity. A low value is calculated on the basis of the assumption that agricultural soil must be considered as part of the economic system. A high value is calculated on the basis of the assumption that agricultural soil is part of the environmental system. In this case, the application of pesticide results in an emission to the soil, excluding the part that is released into water (approximately 1%).
- Besides the impact categories as defined in the CML guide, energy use and final waste are calculated for their practical significance as key indicators in LCA and for their policy relevance on a national level.
- The normalisation data with respect to the depletion of abiotic resources is computed on the basis of apparent consumption data regarding abiotic resources, and is defined as: import + exploitation - export - mutations of resources - bunkers.
- Energy is defined as all of the energy carriers that are used for the production of energy, in accordance with the definition of the Dutch Central Bureau of Statistics. This definition includes sustainable energy sources used in the Dutch economy (solar energy, windmills and incineration of organic wastes). Energy use is expressed in terms of 'Low Heating Value' and 'High Heating Value'.
- The term solid waste concerns material that is disposed of due to production and consumption activities and that finally ends up on a dumping site after waste processing.
- In the event that no equivalency factors of the CML guide are available, a factor is determined for a combination of substances, or for a substance that is comparable to that specific substance.

The Dutch Emission Registration (ER), the Dutch Central Bureau of Statistics (CBS), the Dutch Waste Platform (AAO) and Nefyto (a Dutch branch organisation for pesticide trade and production) supplied the main data sources used in this project. By combining the LCA theory and practice with the available data sources, the following general guidelines have been used:

- Given the reliability of the results of LCA studies, the normalisation data should at least give an impression of the order of magnitude of the environmental burden;
- To guarantee clarity and reproducibility (e.g. in order to enable periodical updating), it is preferable to use a limited amount of acknowledged data sources, to use periodical data sources, and to limit the conversion of data to a minimum.

The data sources, however, involve data that has been collected for purposes other than normalisation. Therefore, it is often necessary to convert the available data into data conform to the definitions set for a certain normalisation level. Well-defined techniques, such as Input-Output analysis and up-scaling based on energy contributions, are used for vital conversions. The data sources and conversion techniques are described below per normalisation level.

[1] It must be emphasised that there are more normalisation levels possible, which are not discussed in this article. For instance, the possibility to scale normalisation levels in relation to the scale of environmental impacts.

3.1 Normalisation data of the Dutch territory

Four periodical data sources are applied to compute the normalisation data of the Dutch territory (ER, CBS, AAO, Nefyto). The main data sources originate from ER [10 - 13], in which ER has published data on 142 emissions to the air and water from 700 registered companies (divided over 59 sectors) for the year 1993. On the basis of this data, ER estimates the emissions of the remainder of the industry sector. Non-industrial emissions are based on statistical data, such as the number of habitants and transport kilometres. To make the data appropriate for further processing, double counts are eliminated and aggregated groups of substances are separated into their individual substances as much as possible. Not all of the environmental data originates from ER. Data concerning the use of pesticides (1992), the use of abiotic resources (1994) and the use of energy (1994) originates from CBS [14 - 17]. Data on soil fumigants originates from Nefyto (1991, 1994) [18]. Leaching to groundwater, evaporation and the uptake by crops are not included in the final emission of pesticides to water. Based on the PESCO-model, which is used to convert pesticide use into pesticide emissions, it is estimated that approximately 1% is lost into the water during application [19]. The remainder, approximately 99%, is assumed to be emitted to the soil. AAO (1994) supplied the data on waste [20].

3.2 Normalisation data of the Dutch consumption

The normalisation data of the Dutch consumption provides an indication of the environmental burden of the Dutch final consumption. This means that products that are produced in the Netherlands, yet consumed abroad, are excluded from the normalisation data of Dutch consumption (e.g. export of Dutch cheese). On the other hand, products that are produced abroad, but consumed in the Netherlands, are included (e.g. import of Italian wines). The basis for the normalisation data of the Dutch consumption is formed by the normalisation data of the Dutch territory.

The so-called Input-Output analysis [21] is used for the allocation of the Dutch and foreign production to the Dutch consumption. The input/output (IO) tables of the Dutch economy of CBS [22 - 25] provide the financial value of all transactions per sector (in the Netherlands there are 59 sectors varying from households to agriculture, etc.). These tables are used to calculate how much all sectors must produce (in financial value), if one sector is to produce one unit of money for the final demand of the consumer. By using the four periodical data sources, it is also possible to determine the environmental burden for the production value of each sector. Combining this data produces a quantification of the environmental burden caused by Dutch consumption. A crucial assumption in this Input-Output analysis is that the environmental burden of the industrial production per unit money abroad is equal to the Dutch production.

The following formula is applied to determine the environmental burden of Dutch consumption:

$$EI_{consumption} = EI_{direct} + a * EI_{indirect\ NL} + b * EI_{indirect\ foreign\ countries}$$

$EI_{consumption}$	:	environmental burden of Dutch consumption
EI_{direct}	:	direct environmental burden of consumers due to use and disposal of products and services, which are fully consumed in the Netherlands (e.g. consumer mobility).
$EI_{indirect\ NL}$	:	indirect environmental burden due to production, transport and services in the Netherlands
$EI_{indirect\ foreign\ countries}$	:	indirect environmental burden due to production, transport and services from other countries, divided into competing and non-competing import
a	:	part of the Dutch production that is allocated to the Dutch consumption, which means that export is not included in (a)
b	:	part of the import of foreign production that is allocated to the Dutch consumption

3.3 Normalisation data of the West European territory

The data sources that could be obtained to compute the normalisation data of the West European territory often appeared to be incomplete and less reliable, especially where they concern emissions that originate from various years (e.g. Corinair [26]). Due to the lower quality of the data, it was decided to carry out a study which was more exploratory in nature. Experiences in computing data for the Dutch situation showed that the total normalisation value, for the most part, was due to a relatively small amount of emissions. Therefore, the total emissions are only quantified for those substances that have a share of >1% in the various impact categories of the normalisation data of the Dutch territory. In the case of omissions, the European data sources are completed with estimates based on the Dutch normalisation data. The West European data on ozone depletion, and the different ecotoxicity scores in particular, strongly depend upon the Dutch information on these topics.

The calculation of normalisation data for Dutch territory proved that energy use determines the following impacts almost completely: global warming, acidification, human toxicity and smog formation. For these impacts it is assumed that extrapolation on energy use is appropriate. Differences in applied energy sources and energy use over the countries are neglected. The following steps are taken to obtain the normalisation data of the West European territory:

- If the same environmental data are available for all 18 countries[2], the information is used for the computation of the normalisation data without further adjustment.
- If only the emission data of group substances is known (in the case of ozone depletion and ecotoxicity), West European normalisation data are extrapolated from normalisation data of the Dutch territory, under the assumption that the mixture of individual substances remains the same.
- If only a limited number of countries provide suitable environmental data (in the case of human toxicity and smog

[2] The data collection is done for the 15 countries of the European Commission (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom) including Iceland, Norway and Switzerland.

formation), the normalisation value is determined on the basis of the amount of energy used in each country according to the following formula:

$$E_t = P_t * (E_k / P_k)$$

E_t : total emission for Western Europe
P_t : total energy use Western Europe
E_k : known emission
P_k : energy use of countries with known emission

4 Results

Table 2 shows the results of the normalisation levels: Dutch territory, Dutch consumption and West European territory. A total of 11 impact categories are quantified. As mentioned in the previous paragraph, a low and a high value have been calculated for the impact categories terrestrial ecotoxicity and energy use.

In addition to obtaining up-to-date normalisation data, the study also provides insight into the contributors to the normalisation data (expressed in substances). This insight is an automatic result of the applied characterisation methods of the CML guide.

Table 3 shows, per normalisation level, which substances contribute to the 11 impact categories. A substance or group of substances is only listed if it contributes over 5% to one of the impact categories of one of the levels.

Table 2: Results of the three normalisation levels

	unit	normalisation data Dutch territory (1993/1994)	normalisation data Dutch consumption (1993/1994)	normalisation data West European territory (1990/1994)
global warming	kg CO2-eq/yr	2.1 E+11	1.4 E+11	4.2 E+12
depletion ozone layer	kg CFC11-eq/yr	4.4 E+06	2.6 E+06	5.6 E+07
photochemical smog formation	kg ethane-eq/yr	1.9 E+08	1.3 E+08	6.3 E+09
acidification	kg SO2-eq/yr	9.2 E+08	5.4 E+08	3.4 E+10
nutrification	kg PO4-eq/yr	1.1 E+09	5.4 E+08	8.6-23 E+09
human toxicity	kg HC-eq/yr	8.8 E+08	6.1 E+08	3.9 E+10
aquatic ecotoxicity	m³ ECA/yr	8.9 E+12	5.1 E+12	4.4 E+14
terrestrial ecotoxicity low	kg ECT/yr	1.2 E+13	8.0 E+12	2.3 E+14
terrestrial ecotoxicity high	kg ECT/yr	1.4 E+14	5.6 E+13	2.5 E+16
abiotic depletion	/yr	6.6 E-03	5.6 E-03	-
energy use low heating value	MJ/yr	2.9 E+12	1.8 E+12	5.8 E+13
energy use high heating value	MJ/yr	3.1 E+12	2.0 E+12	6.1 E+13
solid waste to be dumped	kg/yr	8.8 E+09	14 E+09	9.7-54 E+10

Table 3: An overview of the substances that contribute more than 5% to the different impact categories. The contributions to the normalisation data of the Dutch territory (DT), the Dutch consumption (DC) and the West European territory (WET) are expressed in percentages

Global warming	DT	DC	WET
CO_2	80%	84%	82%
CH_4	6%	6%	6%
N_2O	6%	4%	6%
others	8%	6%	6%

Acidification	DT	DC	WET
No_x	42%	54%	27%
NH_3	40%	17%	22%
So_x	17%	12%	49%
others	1%	17%	2%

Aquatic ecotoxicity	DT	DC	WET
pesticides	61%	44%	81%
Pb Hg Cd Cu Zn	23%	26%	9%
mineral oil	5%	7%	2%
others	11%	23%	8%

Ozone depletion	DT	DC	WET
CF_3Br	22%	31%	24%
$CFCl_3$	21%	30%	29%
$C_2F_3Cl_3$	13%	6%	<1%
CF_2Cl_2	13%	13%	12%
$C_2H_3Cl_3$	7%	6%	9%
CCl_4	4%	15%	15%
others	20%	13%	11%

Smog formation	DT	DC	WET
ethene	8%	9%	<1%
toluene	7%	7%	<1%
xylene	6%	7%	<1%
mineral oil	6%	6%	<1%
aliphatic hydrocarbons	61%	63%	97%
aromatic hydrocarbons	5%	5%	<1%
others	6%	7%	3%

Human toxicity	DT	DC	WET
No_x	49%	53%	26%
SO_x	22%	18%	51%
Ni compounds	5%	2%	2%
Pb compounds	4%	4%	8%
aromatic hydrocarbons	5%	6%	2%
others	15%	17%	11%

Nutrification	DT	DC	WET
N	44%	41%	49%
P	43%	44%	26%
NO_x	6%	10%	14%
NH_3	6%	5%	11%
others	1%	0%	0%

Energy use*	DT
gas	50%
oil	35%
coal	12%
others	3%

Terrestrial ecotoxicity (high)	DT	DC	WET
pesticides	70%	74%	97%
Zn compounds	7%	9%	<1%
others	23%	3%	3%

Abiotic depletion*	DT
Hg	37%
Tin	18%
Pb	14%
Zn	11%
oil	7%
gas	6%
others	7%

Solid waste*	DT
domestic waste	25%
waste of building materials	18%
industrial waste	12%
waste of non industrial companies	9%
waste of sanitary departments	6%
others	30%

Terrestrial ecotoxicity (low)	DT	DC	WET
Zn compounds	89%	63%	89%
Cu compounds	7%	4%	7%
others	4%	33%	4%

*Although the impact scores of energy use, abiotic depletion and solid waste are computed for all three normalisation levels, the main contributors of these impact categories have not been worked out for the normalisation data of the Dutch consumption and the West European territory. Furthermore, it should be emphasised that the calculated contributions are directly dependent upon the applied characterisation methods of the CML guide (and the accessory equivalency factors).

Table 3 shows, for example, that approximately 80% of the global warming in the Netherlands and Western Europe is caused by CO_2-emissions. Aquatic ecotoxicity is mainly caused by pesticide use in agriculture. The differences between the main contributors to the two Dutch normalisation data are relatively small. The differences between the Dutch and the West European main contributors are sometimes considerable. The level of acidification in the Netherlands, for example, is mainly caused by NO_x and NH_3, whereas SO_x is the largest contributor in Western Europe. The same is valid for human toxicity, of which the main contributors are NO_x and SO_x. Nevertheless, the type of contributors, that is to say the substances listed in Table 3, are practically the same for all three levels of normalisation. Also, Table 3 shows that a remarkably low number of substances (< 10) accounts for 80-95% of the environmental burden of an impact category.

Although the results in Table 3 provide a very clear view of the main contributors, one must not forget the underlying assumptions (e.g. characterisation methods of the CML guide). It is, for example, not possible to establish priorities right away, because the results only refer to potential impacts and not to actual impacts (as is always the case in LCA).

5 Discussion

The discussion focuses mainly on the unreliability of the new normalisation data. Here, unreliability is partly caused by the unreliability of known information (defined as uncertainty), and partly by the unreliability of missing information (defined as incompleteness). Unreliability is an aspect to be considered throughout the entire process of generating data, including the uncertainty and incompleteness within data sources, data treatment techniques and the LCA theory and practice. Furthermore, attention is paid on the improvement, actualisation and maintenance, and application of normalisation data in the Netherlands.

5.1 Unreliability Dutch territory

The study focused ample attention on the unreliability of the calculated data, particularly in the case of the normalisation data of the Dutch territory. The uncertainty has been estimated, as it can be traced back to the applied data sources. Incompleteness is very hard to quantify and reflects a general problem in LCA. This is especially relevant when there is cause to believe that the unknown information is more significant than the known information (e.g. not monitored emissions). Nevertheless, the study attempts to provide a qualitative estimate of the unreliability of the normalisation data of the Dutch territory. Therefore, unreliability is defined as consisting of the following elements:

- Uncertainty concerns the variation in the reported annual emissions in ER; the use of gross emissions instead of net emissions in ER (e.g. waste water treatment plants are not included); and the uncertainty of the data concerning the use of pesticides that are reported in [14] and [18]. The uncertainty of the data sources concerning energy and abiotic depletion [15 - 17] is relatively low. The incompleteness of data sources concerns the emissions that were not monitored. This is especially relevant for smog formation and the toxicity impact categories.
- Unreliability of the data treatment techniques concerns the uncertainty of extrapolations made in ER and the uncertainty of the PESCO-model, which is used to convert pesticide use into pesticide emissions [19].
- In the case of the LCA theory and practice, the unreliability concerns uncertainties in the applied system boundaries, which are especially relevant where terrestrial ecotoxicity is concerned; and the unreliability of the applied characterisation methods per toxicity impact category (e.g. missing equivalency factors).

Each impact category and each element of unreliability is given one of the following scores: small, moderate or considerable. Small implies that the unreliability is not thought to be of relevance in the practical application of normalisation in LCAs. Moderate implies that the unreliability is relevant, and considerable implies that the unreliability is an important factor to be taken into consideration in the interpretation of LCA results. This results in a final qualification of the unreliability for each impact category in one of the three categories (→ *Table 4*).

Table 4: Qualification of the unreliability of the 11 impact categories

Small	Moderate	Considerable
global warming	ozone depletion	human toxicity
acidification	smog formation	aquatic ecotoxicity
abiotic depletion	nutrification	terrestrial ecotoxicity
energy use		
solid waste		

The unreliability of the toxicity impact categories is estimated to be considerable due to the unreliability of the data sources, the data treatment techniques and the applied characterisation methods. The unreliability where it concerns nutrification is qualified as moderate due to the differences between the gross and net emissions in ER (the up-take of nutrients by crop is not taken into account, which leads to an overestimation of the total loading). The unreliability where it concerns smog formation is qualified as moderate due to the uncertainty of the data sources and the relatively high percentage of group substances instead of individual substances (→ *Table 3*, aliphatic hydrocarbons). The unreliability where it concerns ozone depletion is mainly influenced by an external factor, namely a strict CFC policy that causes a clearly diminishing trend[3], and is therefore also qualified as moderate. The unreliability of the remaining impact categories is qualified as relatively small in comparison to other unreliabilities in LCA.

[3]Note that when the ozone depletion normalisation value is halved, the normalised contribution of a product to this impact category is doubled. This shows once more that normalisation is an initial step of the interpretation (normalisation gives insight in the significance of impact categories) and is connected with the weighting step (weighting gives insight in the relative importance of impact categories). It is likely that in this case, as a consequence of a strict CFC policy, the weighting factor of ozone depletion would diminish.

5.2 Unreliability of Dutch consumption and West European territory

A qualification of the uncertainty concerning the normalisation data of the Dutch consumption and the West European territory has not been given. However, since the normalisation data of the Dutch consumption is calculated from the normalisation data of the Dutch territory and therefore undergoes more conversions, it is assumed that this data is less reliable. The normalisation data of the West European territory is less reliable because of the quality of the data from the data sources used and the applied extrapolation for ozone depletion, ecotoxicity, human toxicity and smog formation. The data for global warming and energy use is considered to be relatively reliable.

5.3 Improvement of normalisation data

Since the unreliability in the normalisation data is still believed to be considerable, particularly where toxicity is concerned, further improvements can be made in the near future. It is recommended to focus on the following aspects when attempting to improve the normalisation data of the Dutch territory:

- Actualisation of the equivalency factors, especially for the toxicity impact categories
- A quantification of the uncertainty of normalisation data, including all of the factors that cause this uncertainty, such as the uncertainty and incompleteness of the data sources, data treatment techniques and the equivalency factors
- A more explicit definition of the demarcations concerning activities and emissions, clearly defining which activities and emissions are excluded in data sources on a national level and for what reason
- More complete modelling of the emissions into soil, including the consistency in system boundaries between economy and nature regarding all activities and the modelling of emissions.

The normalisation data of the Dutch consumption can be improved by giving special attention to the assumptions made in the Input-Output analysis, such as the allocation of environmental interventions to Input-Output sectors and the allocation of the environmental burden of the Dutch production over consumption and export, and to the assumptions made for the environmental burden of import (e.g. mining and agriculture). More knowledge concerning the environmental burden of import would also increase the possibility of providing a useful estimate of the normalisation data on a world scale.

The normalisation data of the West European territory can be improved through further research on the consistency of applied definitions of impact categories between the countries, the reliability of the data sources, and the method for filling in the gaps in the data on environmental information from member countries.

5.4 The actualisation and maintenance of normalisation data

There are two main reasons for actualisation. The first reason is the accuracy of normalisation data. A normalisation set is only adequate for a certain period. How long depends upon the differences in the speed of changes in the normalisation data, which are induced by environmental policy for example (e.g. ozone depletion). The second reason for actualisation might be the implementation of adaptations in the characterisation methods, or the fact that additional operations are added on. An example of an additional operation is using net emissions instead of gross emissions, which would give a more reliable estimate of the normalisation data (e.g. nutrification).

A good structure in terms of organisation and data sources is important for the actualisation and maintenance of normalisation data. It is recommended that all possible adaptations and improvements are centralised at one point. For efficiency reasons, it is also recommended to make authorised data sources responsible for the computation of the normalisation data. This would guarantee the actualisation and maintenance of this data and would provide a suitable structure to improve it.

5.5 Application of normalisation data in the Netherlands

Besides reliability, general consensus is important where the acceptance of new normalisation data is concerned. From this point of view, it is interesting to know that the guidance group had a wide composition: governmental institutes (RIZA, VROM, RIVM), universities (UvA/IVAM, RUL/CML, UU/NWS), agencies specialised in LCA (PRé, DHV) and the industry sector (Unilever). Furthermore, the project has been checked by means of three (limited) peer reviews that were carried out by CML, ECN and TNO. As a result, the normalisation data are widely used in the Netherlands, they are incorporated in the PRé LCA-software Simapro 4.0 [27], and they will be included in the update of the CML guide, which is currently in progress.

6 Conclusions and Recommendations

The normalisation study has resulted in an update of normalisation data of the Dutch territory and new normalisation data for final consumption and the West European territory. A working method has been described which can be used as a framework to actualise normalisation data in the future. The following conclusions and recommendations can be made concerning the improvement, application, actualisation and maintenance of normalisation data.

Firstly, it is possible to calculate new normalisation data in consistency with the applied equivalency factors. This may prove important when new and/or revised equivalency factors and/or emitted substances become available (e.g. with the update of the CML guide). Interesting to note, as is shown in *Table 3*, is that just a limited number of substances is responsible for 95% of the normalisation data. Therefore, reliable emission data of the most contributing substances and accessory reliable equivalence factors are of more importance than the need to have an (over)complete list of substances. This need of completeness is often seen as a fundamental flaw in the concept of normalisation since more emission data and accessory equivalence factors lead to higher normalisation data in theory. In practice, however, this need appears to be

only a serious problem when equivalence factors and/or emitted substances alter substantially.

The application of sub world normalisation levels implies that the LCA practitioner should describe the motives for his choice transparently. Interesting is the question of whether or not to apply normalisation data of the Dutch final consumption. In theory, this level of normalisation would prove a perfect match for the subject of many LCAs. In practice, however, the unreliability of this data is still considerable. The unreliability of the environmental burden of import is probably crucial in the evaluation of the usefulness of normalisation data based on final consumption. For the time being, it is advisable to use the (more reliable) normalisation data of the Dutch territory in the Dutch situation. In the West European situation, the West European normalisation data can be used.

In the background report, assumptions and conversions are soundly described in order to guarantee the transparency of and the consistency in the calculation of the normalisation data. However, insights of how normalisation data should be calculated can alter quickly. For this reason, the background report can not be considered as a guideline yet. It is crucial to create procedures for calculating normalisation data, but even more important is the set up of a platform which is responsible to periodically actualise this data.

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